

Name: _____

Exam 2

Foundations of Computer Science
Fall 2007

This exam is open book, open notes, open computer, but **you may not run Prolog**. You may use your computer to access general documentation, but not to search for answers to questions on this exam.

1 Context Free Languages (18 points)

1. Draw a parse tree for the string $a \times (a+a+a)$ and the CFG

$$\begin{aligned} E &\rightarrow E + T \mid T \\ T &\rightarrow T \times F \mid F \\ F &\rightarrow (E) \mid a \end{aligned}$$

2. Write a CFG for the following language on $\{a, b\}$:

$\{w \mid \text{the number of } a\text{s in } w \text{ is at least the number of } b\text{s}\}$

3. Let B be the language of all palindromes over $\{0, 1\}$ containing an equal number of 0s and 1s. Sketch the proof that B is not context free. Make sure the logic of the proof is clear.

2 Prolog (12 points)

1. Suppose you have a database of rules like this:

```
bday(kurt_godel, apr28).  
bday(alonzo_church, jun14).  
bday(alan_turing, jun23).  
bday(johannes_gutenberg, jun23).  
bday(jay_leno, apr28).  
bday(boy_george, jun14).
```

where `bday(A,D)` means that `D` is the birthday of `A`. Write a set of rules that finds pairs of people in the database that have the same birthday. Write a query that shows how you would use your rules to enumerate all pairs.

2. Explain the following rules in two ways. First, give a declarative interpretation; that is, what property is defined by these rules. Then give an operational description; that is, what computation do these rules perform? For the second part, you can specify a particular query if it helps.

```
mystery([],_).  
mystery([F|R1],[F|R2]) :- mystery(R1,R2).
```


